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AUTHOR Billings, Paul H.
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ABSTRACT

This instructional guide, one of a series developed by the Technical Education Advancement Modules (TEAM) project, is a 6-hour introductory module on statistical process control (SPC), designed to develop competencies in the following skill areas: (1) identification of the three classes of SPC use; (2) understanding a process and how it works; (3) tracking the process; and (4) analyzing the process. Project TEAM is intended to upgrade basic technical competencies of unemployed, underemployed, and existing industrial employees. The materials in this module serve as a student outline and an instructor guide. The manual includes six sections: (1) introduction--including course objectives and classes of SPC use; (2) what is a process; (3) how a process works; (4) Dr. W. E. Deming's plan to save America--the assignment of responsibilities and the master plan for process improvement; (5) tracking the process--the average and range chart, and detecting lack of control; and (6) analyzing and removing special causes--individual and team problem solving, simple diagnostic tools, and return to Deming's plan. (NLA)

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ED328693

PROJECT T.E.A.M.

(Technical Education Advancement Modules)

INTRODUCTION TO STATISTICAL PROCESS CONTROL

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GREENVILLE TECHNICAL COLLEGE

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PROJECT TEAM
TECHNICAL EDUCATION ADVANCEMENT MODULES

INSTRUCTIONAL MODULE:

INTRODUCTION TO STATISTICAL PROCESS CONTROL

Developed by:

Paul H. Billings

Funded by:

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Introduction:

The purpose of this manual is to serve as an instructional guide for the TEAM Grant module Introduction to Statistical Process Control.

Introduction to Statistical Process Control is a six hour overview course intended to develop competencies in the following skill areas:

Identification of the Three Classes of SPC Use
Understanding a Process and How It Works
Tracking the Process
Analyzing the Process

Overview of Project TEAM:

Project TEAM (Technical Education Advancement Modules) is a program targeted toward the unemployed, underemployed, and existing industrial employees who are in need of upgrading basic technical competencies. The program seeks to give adequate preparatory educational opportunities in generic technical skill areas and to create a public awareness of the need for these basic skills. Curriculum content was determined by an assessment team of local industrial employers. Their evaluation resulted in the development of 15 instructional modules; some of which may be industry specific, but most of which are applicable in and necessary to a majority of industrial settings. The modules may be used collectively or as a separate curriculum for a specific course or courses. The material contained in each manual will serve as a student outline and as an instructor guide which may be used selectively or in its entirety.

Project Team

1. Course Title Introduction to Statistical Process Control	2. Session Number

ESSENTIAL INFORMATION

3. Course Objectives

To expose the student in a generalized manner to the purpose and process of SPC..

4. Tools, Equipment, and Materials needed

Text

5. Training Aids Needed

Miscellaneous Transparencies
Video - "Continual Improvement-U. S. Style"

6. Time Allotted

two sessions at 3 hours (360 hours)

SESSION OUTLINE	HANDOUTS	TIME
Introduction Three classes of SPC use What is a Process How a Process Works Dr. W. Edward Deming's Plan to Save America Tracking the Process Analyzing and Removing Special Causes		

INTRODUCTION TO STATISTICAL PROCESS CONTROL

1. INTRODUCTION

   A. Objectives, Expectations and Outline of the Course
   B. The Three Classes of SPC Use
   C. Continual Improvement...U.S. Style

2. WHAT IS A PROCESS?

   A. General Definitions
   B. Parts of the Process

3. HOW A PROCESS WORKS

   A. Causes of Variation in the Process
   B. The Dice Process and the Central Limit Theorem
   C. The Two Kinds of Variation in the Process

INTRODUCTION TO STATISTICAL PROCESS CONTROL

4. DR. W. EDWARDS DEMING'S PLAN TO SAVE AMERICA

   A. The Assignment of Responsibilities
   B. The Master Plan for Process Improvement

5. TRACKING THE PROCESS

   A. The Average and Range Chart
   B. Ways of Detecting Lack of Control-Special Causes

6. ANALYZING AND REMOVING SPECIAL CAUSES

   A. Individual and Team Problem Solving
   B. Simple Diagnostic Tools
   C. Return to Deming's Plan to Save America

NOTES:

1. INTRODUCTION TO STATISTICAL PROCESS CONTROL

   A. Objectives, Expectations and Outline of the Course

   B. The Three Classes of SPC Use

THE THREE CLASSES OF SPC USE

1. **Class 1** - Using SPC only as a way to adjust the machine or process. Involves keeping charts to adjust the process as it drifts

   Although this control is helpful, it only reaps possibly 10% of what is available through SPC.

2. **Class 2** - Using SPC as a way to improve the process. Control charts are used as detection devices for special problems in the process. The charts are also used as a history of the process so it can be continuously improved - Management seeks for ways to improve the processes and supports the workforce-

3. **Class 3** - Using SPC as a way to run a company. Has all the attributes seen in Class 2 plus management seeks to create a culture that supports SPC in all areas of the company - Other "World Class" ideas like JIT Techniques, Total Quality Organization and Total Employee Involvement are often used with SPC. Deming's 14 points are used as a guideline.

NOTES:

C. Video- Continued Improvement...US Style

2. WHAT IS A PROCESS?

A. General Definitions

VERNAY TEAM CHARTER

Improve Quality and Reduce Costs To Improve Our Competitive Position

A. Improve consistency throughout the process: Day-to-day, shift-to-shift, and operator-to-operator

B. Reduce Scrap---
With resulting reduction in inspection costs

C. Increase productivity through improved facilities and methods

D. Provide all team members opportunities for personal growth through training and experience using the seven tools for improvement (Process charts, fishbone charts, histograms, run charts, scattergrams, Pareto charts, control charts)

NUTTY BROWNIE SQUARES

1 1/4 cups Quaker Oats (quick or old fashioned, uncooked)
1/2 cup margarine, melted
1/4 cup cocoa
1/2 cup sugar
1 egg white or whole egg
1 teaspoon vanilla
1/3 cup all-purpose flour
1/3 cup chopped nuts

1. Heat oven to 350°F
2. Spray 8 inch square baking pan with vegetable oil cooking spray or oil lightly
3. Place oats in blender or food processor; cover. Blend about 1 minute, stopping ocassionally to stir; set aside
4. Combine margarine and cocoa
5. Add sugar, egg white and vanilla, mixing well
6. Stir in oat flour and remaining ingredients; pour into prepared pan.
7. Bake 15 minutes for chewy brownies, 17 minutes for more cake-like brownies.
8. Cool; cut into 2 inch squares - 16 servings

PARTS OF THE PROCESS

PEOPLE

METHODS

MATERIALS

MACHINES

ENVIRONMENT

MEASUREMENT SYSTEM

NOTES:

B. Parts of the Process

3. HOW A PROCESS WORKS

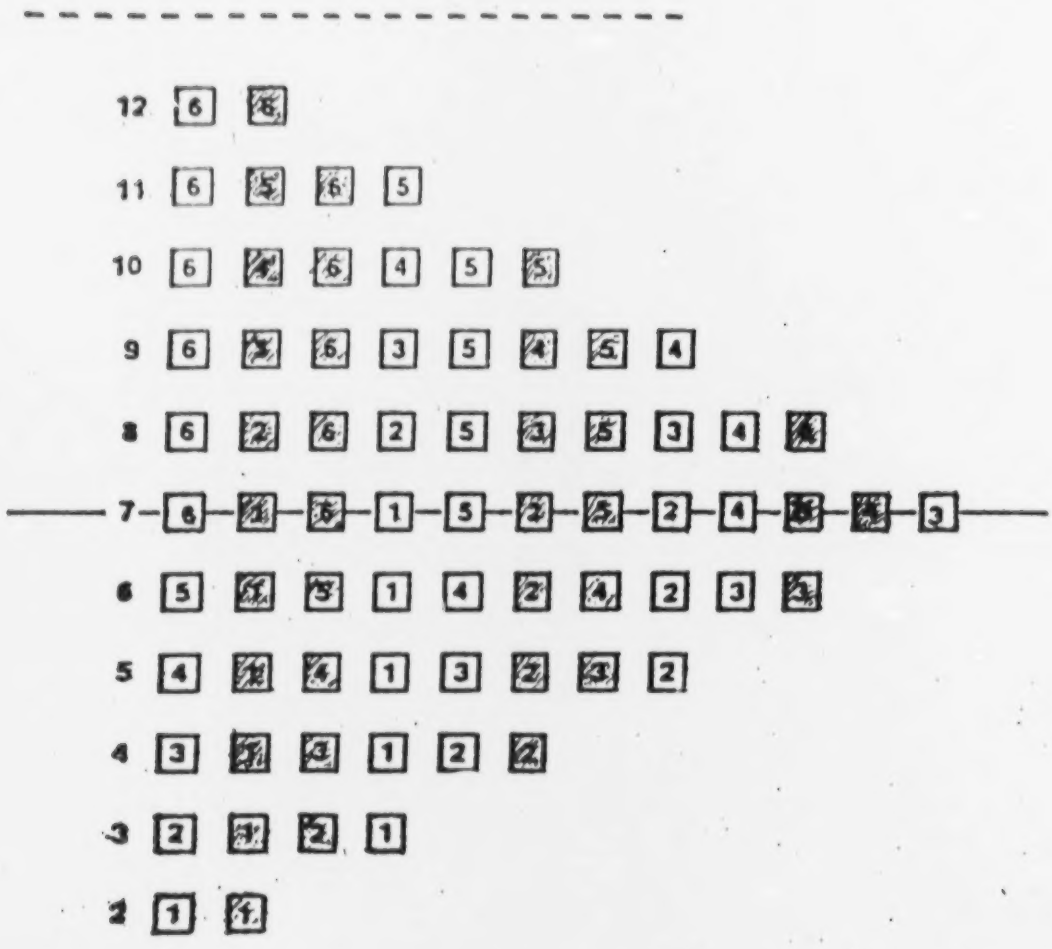
A. Causes of Variation in the Process

NOTES:

B. The Dice Process and the Central Limit Theorem

C. The Two Kinds of Variation in the Process

When throwing a pair of dice (the dice process) there are 36 possibilities. When a working process moves there are thousands of possibilities-



Because all things causing variations in the process average out against each other the process variation tends to stay near the center of what is possible with relatively fewer and fewer points seen as it gets farther and farther away from the center

TWO KINDS OF VARIATION

Common Cause Variation

Common cause variation is the basic variation in the process coming from the six parts of the process: people, methods, materials, machines, environment and measuring system. It is characteristic to the process and it can only be changed by making a basic change in the process.

Special Cause Varitation

This is sometimes called "assignable cause". Special causes variation is something out of the ordinary happening to the process that causes greater variation in the process output. It will often come and go, develop into a trend or otherwise show up in a non-random pattern in the process. By tracking the process through control charts these special causes can be pinpointed, removed and the process be held in a stable, "in control" pattern. When the process is in control or stable, only the common causes basic to the process are determing the variation "spread" in the output.

NOTES:

4. DR. W. EDWARDS DEMING'S PLAN TO SAVE AMERICA

A. The Assignment of Responsibilities

B. The Master Plan for Process Improvement

MANAGEMENT

The group responsible for designing the processes and systems and has the power to change them

LOCAL WORKFORCE

The group responsible for running the processes and systems as they are and keeping them in a stable condition

DEMING'S 14 POINTS

1. **Create Constancy of Purpose to Improve Products and Services**

   - Plan to be competitive and stay in business- Look to long term continuing results

2. **Adopt the New Philosophy**

   - We are in a new economic age-
   - We can no longer live with accepted levels of defects and mistakes

3. **Cease Dependence on Mass Inspection for Quality Control: Instead, Depend on Process Control Through Statistical Techniques**

   - The right quality must be built in
   - Production people must learn SPC

4. **End the Practice of Awarding Business on the Basis of Price Tag Alone**

   - We can no longer leave quality to the force of competitive bidding- Purchasing agents have a new job-
   - We must require statistical evidence of quality
   - It is the "total cost of use" not the price tag that is of consequence

5. **Use Statistical Methods to Find Out, In any Trouble Spot, What are the Sources of the Trouble**

   - Use statistical techniques to determine if the trouble is coming from the system or from things controlled by the local workforce

6. **Institute Modern Aids to Training on the Job**

   - Use statistical methods to determine when training is complete- Whether an employee is capable

   - Create training that ensures the lowest amount of variation coming from the work

7. **Institute Modern Methods of Supervision**

   - Supervision is part of the system and the responsibility of management

   - Supervisor must be given more time to help the people

   - Make certain supervisor knows in detail which defects are caused by the system and which caused by the workforce

8. **Drive Out Fear**

   - Most workers and managers do not understand their jobs and are afraid to ask

   - People must feel secure to: ask questions, make suggestions and report trouble

   - Organizational fear is major detriment to everyone working to their maximum potential

9. **Break Down Barriers Between Departments**

   - People in design, marketing, purchasing and manufacturing must learn to work together
   - Each department often builds its own empire to the detriment of the company
   - Multidiscipline teams should be used to set the pace for change with company

10. **Eliminate Numerical Goals, Slogans, Pictures, Posters Urging People to Increase Productivity, Sign Their Work, Etc,. Without Providing the Means to Achieve the Desired End**

   - Original Zero Defect program did not work because no way given to change systems-
   - Numerical goals have negative, frustrating effect if means not given to accomplish them
   - Exortation to better work usually the act of a befuddled management that doesn't know course to take to continuing improvement

11. **Eliminate Work Standards that Prescribe Numerical Quotas**

   - Do not help anyone do better job- Quotas too tight leads to more defects- Quotas too loose lead to wasted time- Statistical data provides better information

12. Remove Barriers that Stand Between the Hourly Worker and His Right to Pride In Workmanship (Also for Everyone In Organization)

- Management's primary responsibility is to provide the "tools" people need to do their jobs

- Must have "formal" and "informal" systems set up to keep in touch with workers and the "tools" they need

13. Institute a Vigorous Program of Education and Retraining

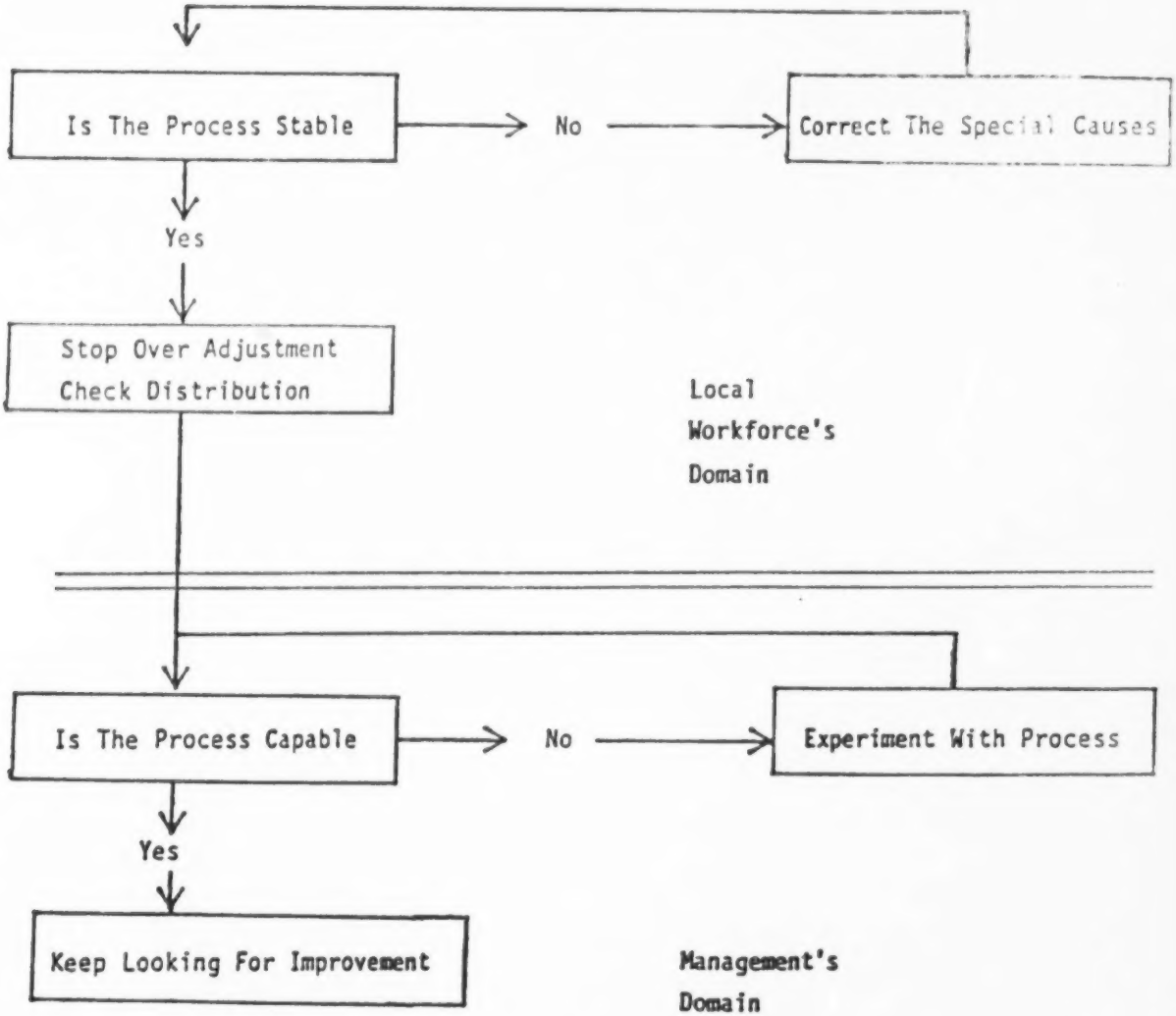
- Basic statistical methods are not difficult but must be used in the way advocated by Dr. Deming

- Training program should stay current with changes in methods, materials, machines, customers, vendors, etc.

14. Create a Structure in Top Management That will Push Every Day on Points:

#1 through #13

MASTER PLAN FOR IMPROVEMENT



NOTES:

5. TRACKING THE PROCESS

A. The Average and Range Chart- XR

B. Ways of Detecting- Lack of Control (Special Causes)

CALCULATING THE "BORDERS" OF THE "ROAD"

AVERAGE CHART

Samples of product taken in work-run order

Subgroup averaged and plotted on chart

"Middle of road" is average of all the subgroups

Upper edge of road, Upper Control Limit, determined by simple math formula

Lower edge of road, Lower Control Limit, determined by same formula

RANGE CHART

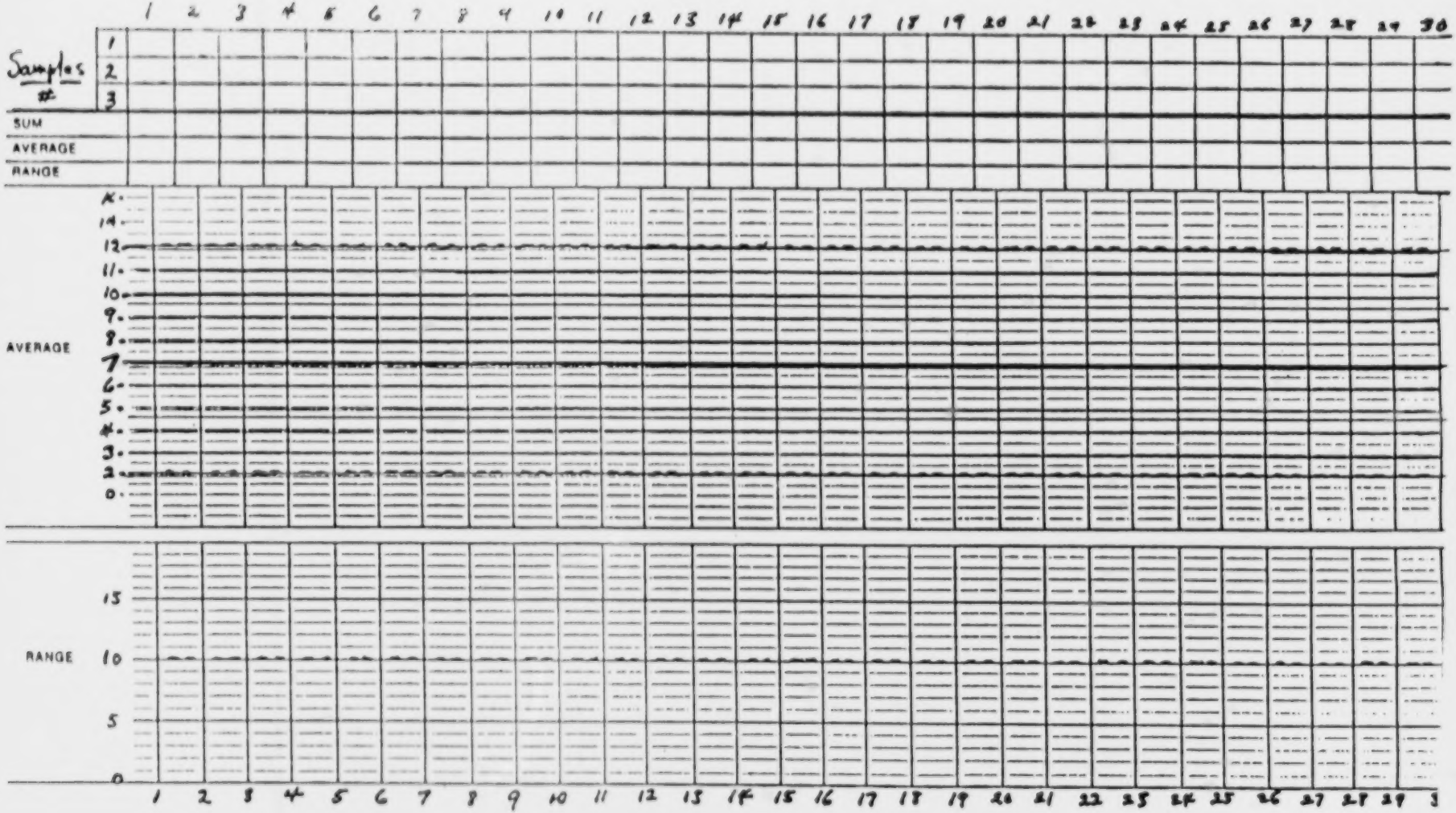
"Middle of road" is average of all the ranges or "spreads" within the subgroups

Upper edge of road, Upper Control Limit, determined by simple math formula

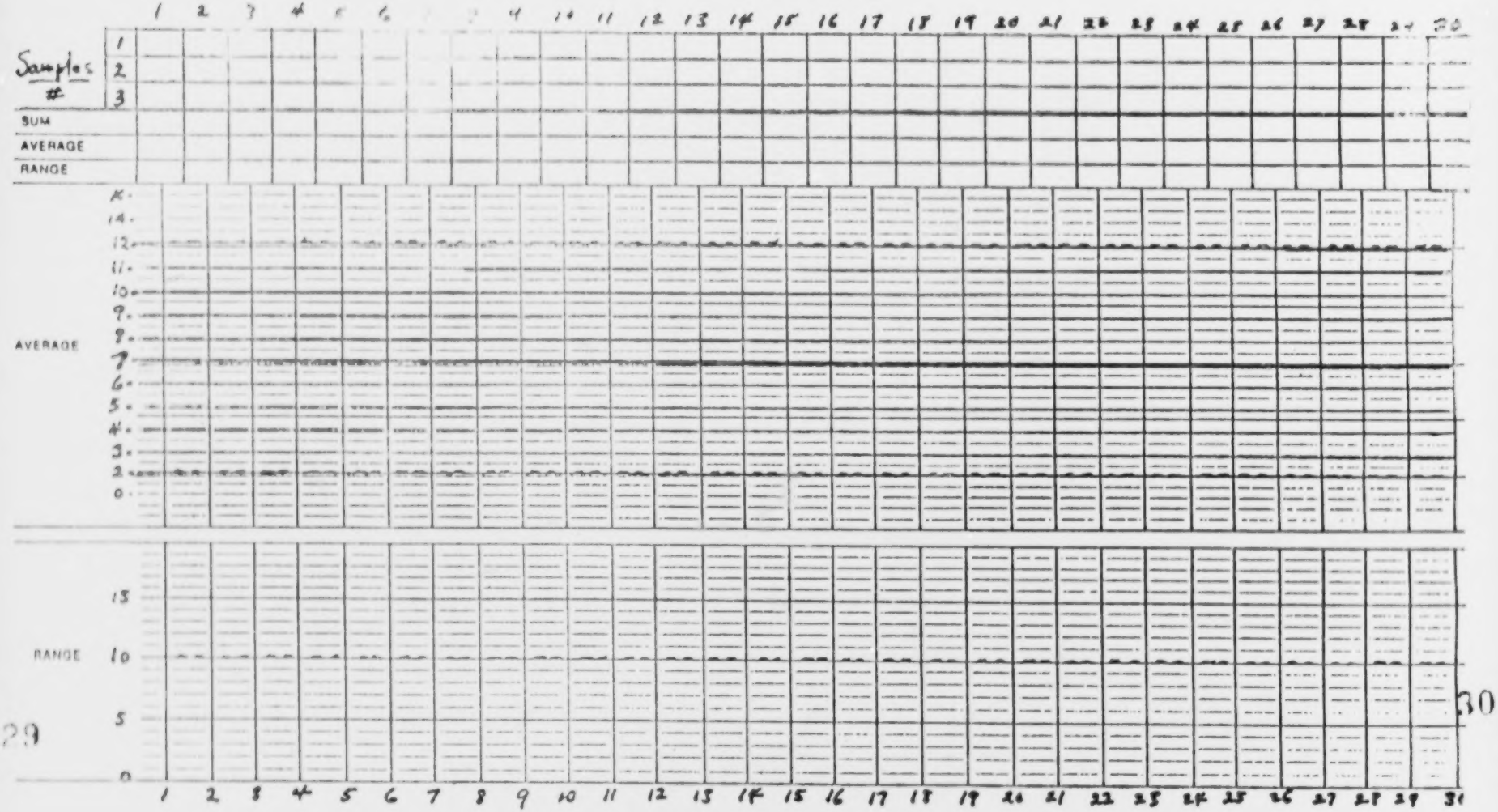
Lower edge of road, Lower Control Limit, for the range is usually 0

$\bar{X}R$ CHART (Samples of 3)

22.



$\bar{X}R$ CHART (Samples of 3)



FOUR WAYS OF DETECTING SPECIAL CAUSES (LACK OF CONTROL)

1. Points outside the control limits

2. Seven or more consecutive points falling on one side of the central line

3. Seven or more consecutive points showing a steady increasing or decreasing trend

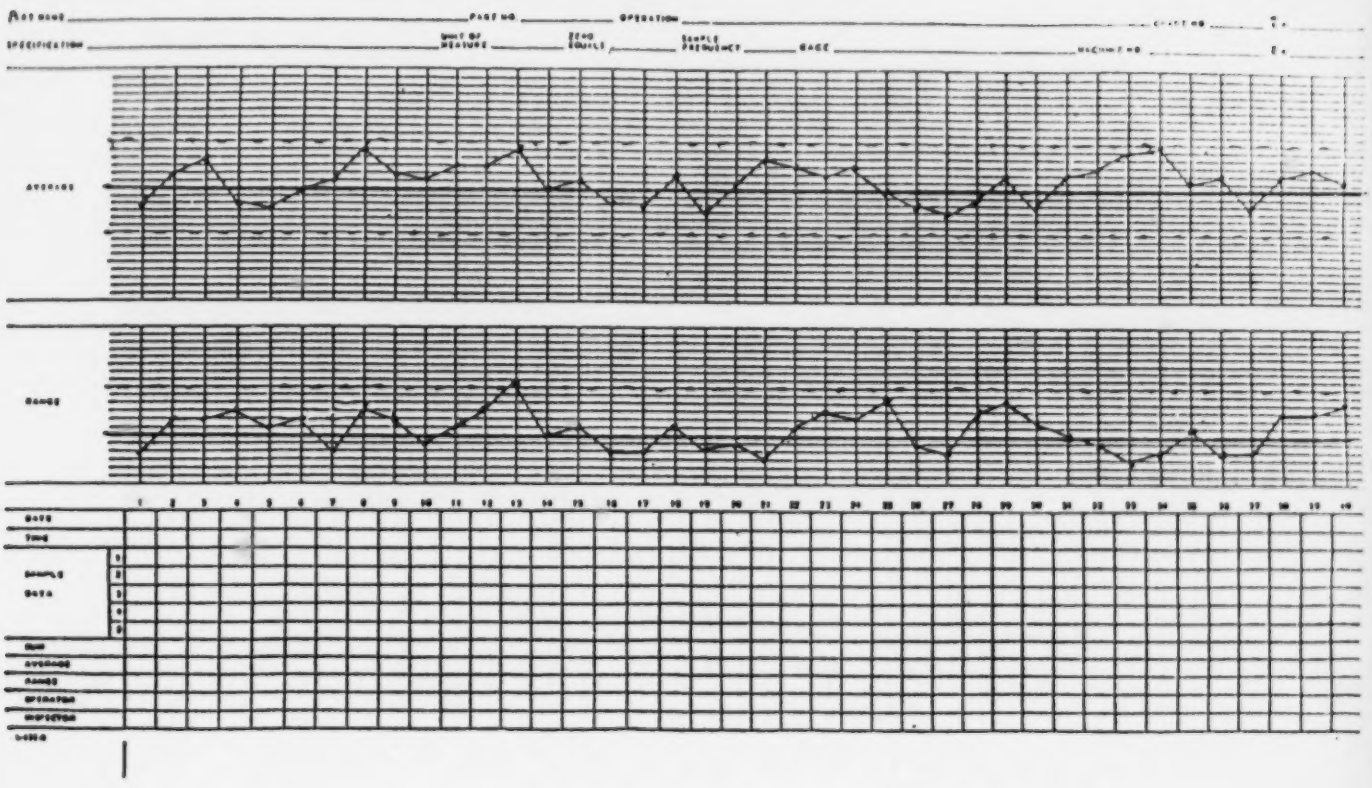
4. Number of times crossing the central line shows a non-random pattern.

   Examples: With 10 points, times crossing the central line should be 2 to 9, with 20 points 5 to 16, with 30 points 9 to 22, with 40 points 13 to 28

Note: More than twenty ways of detecting special causes are available. Trying to learn all the ways is unnecessary. If special causes are in the process, non-random patterns will be detected by one or more of these tools-

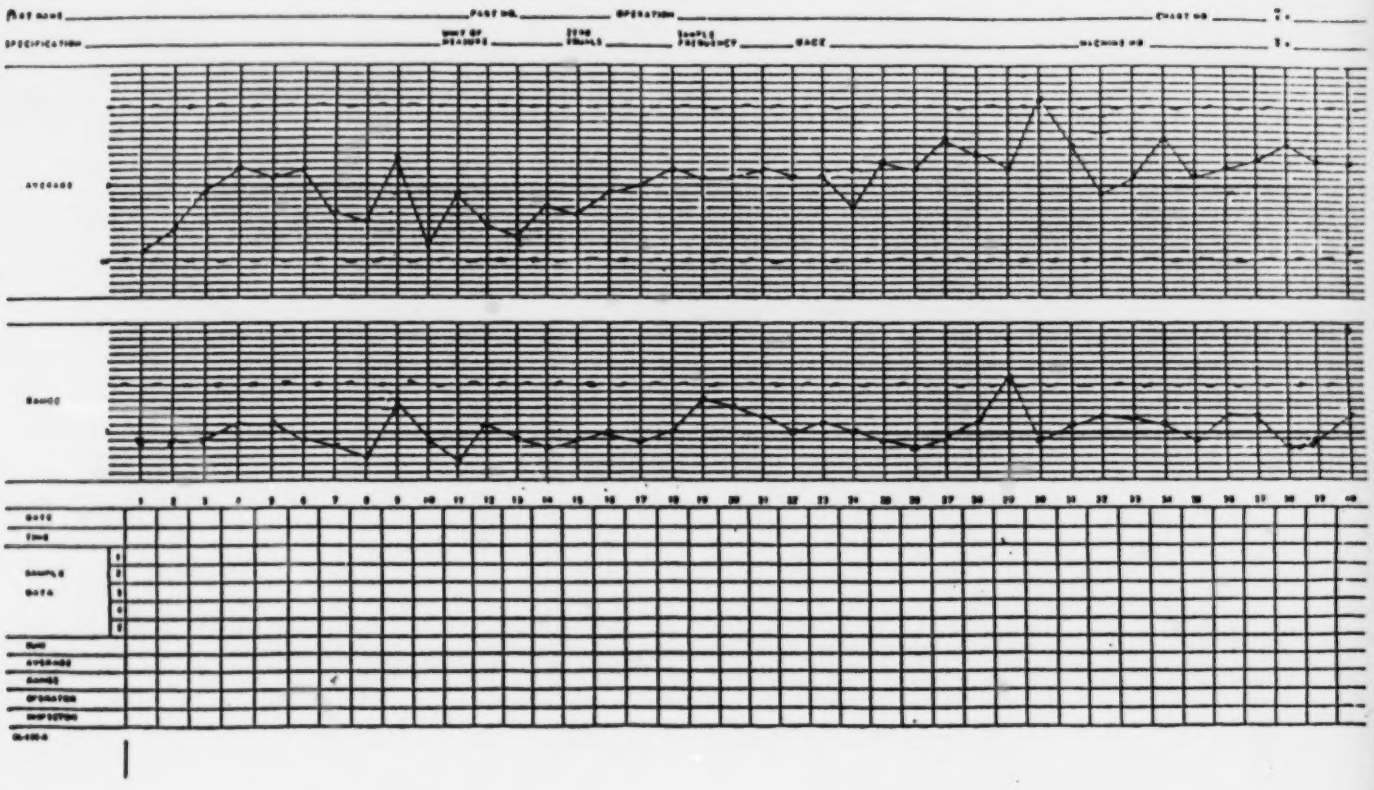
AVERAGE AND RANGE CHART

#1



#2

AVERAGE AND RANGE CHART



NOTES:

C. Other Charts

6. ANALYZING AND REMOVING SPECIAL CAUSES

A. Individual and Team Problem Solving

ATTRIBUTE CHARTS

Attribute charts do not record actual measurements. They record number of bad units or defects.

p Chart- Plots the proportion of bad units per subgroup. (Subgroups usually 50 or more)

np Chart- Plots the number of bad units per subgroup. (Subgroups of 50 or more and constant number)

u Chart- Plots the number of defects per unit when the possible number of defects is uncertain

c Chart- Plots the number of defects per unit when the number of defects per unit is a set number

ANALYZING AND REMOVING SPECIAL CAUSES

ASK " W H Y " 5 TIMES

TEAM PROBLEM SOLVING

1. Look at information- Separate causes from symptoms- Narrow scope
2. Brainstorm among those who know process- Use diagnostic tools- Choose alternatives
3. Look at alternatives- Collect data- Study- Make choice
4. Sell choice- Put into effect
5. Monitor results until data proves problem solved or improved- Go back to #1

NOTES:

B. Simple Diagnostic Tools

C. Return to Demings Plan to Save America

SIMPLE DIAGNOSTIC TOOLS

1. Brainstorming
2. Cause and Effect (Fishbone) Charts
3. Pareto Diagrams
4. Flow Diagrams
5. Defect Location Checksheets (Pictographs)
6. Scatter Diagrams
7. Frequency Tables and Histograms
8. Run Charts

DEMING'S PLAN TO SAVE AMERICA

- All U.S. business using Class 3 statistical process control
- All people in enterprise realizing that one of main purposes for their existence in the enterprise is to take variation and waste out of processes
- Begins with basic knowledge and practice of SPC and grows with advanced statistical understanding
- To be in a continuous improvement process- a lifetime task for everyone in society